PhD in Electrical, Electronics and Communications Engineering

Research Title: Advanced signal design for satellite navigation systems

Funded by	Dipartimento di Elettronica e Telecomunicazioni (DET) Prof. Fabio Dovis

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Context of the research activity	The civil applications of geopositioning are experiencing a fast and widespread development. The update of the Global Positioning System (GPS), of GLONASS and the operational phase of Galileo and Beidou, in the past year, are pushing into the market new mainstream, professional and scientific applications. Intelligent Transport Systems (ITS), autonomous vehicles, drones and robots, Location Based Services (LBS), for smartphones and tablets are just few examples of applications and services that rely on Global Navigation Satellite Systems and have a huge impact in the future smart society. Nevertheless, research is already looking at the modernization of the signals for the new generation of GPS and for the Galileo evolution. New signals needs to be designed in order to match the user requirements for better accuracy and precision of the positioning systems, but also new protection techniques against malicious jammers and spoofers, to grant the reliability of the estimated position. The European Commission and the European Space Agency are spending a large effort for the preliminary design of the second generation of Galileo satellites, and research on new architectural signals able to grant improved performance is still needed.

Objectives	The objective of the PhD grant is to support the study of new signal structures for satellite navigation positioning. Such a study will start form the most recent research results that theoretically demonstrated how multichannel signals can lower the theoretical uncertainty bound on the estimated position. Such a design must take into account the backward compatibility with current systems, the available bandwidth in the frequency spectrum and assess the impact in terms of complexity for the satellite payload and the user receivers. However, many degrees of freedom are still available in order to obtain an optimized design. In summary the following aspects have to be addressed - the design of a multichannel signal architecture in terms of modulations, codes, carriers and navigation data messages - the assessment (theoretical and by simulation) of the impact on the design and implementation of the satellite payload - the design of suitable users receiver architectures exploiting the concept of meta-signals (synchronized channel combination) - the performance assessment, in particular with respect to propagation impairments (e.g. ionosphere, multipath) and harsh environments - the design of cryptographic techniques to grant robustness to spoofing and jamming (link-layer coding) The work will be performed by means of theoretical studies and simulation campaigns using proper software tools, as well as through experimental activities in the lab.

Skills and competencies for the development of the activity	Knowledge of positioning principles and satellite navigation basics is necessary as well as excellent skills in signal processing and digital communications. Skills and tools: - C/C++ programming - Matlab - Simulation of communication systems and receivers